Truth table of AND gate

A	B	**F**
0	0	**0**
0	1	**0**
1	0	**0**
1	1	**1**

Truth table of OR gate

A	B	**F**
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**1**

Truth table of half adder

A	B	**S**	**C**
0	0	**0**	**0**
0	1	**1**	**0**
1	0	**1**	**0**
1	1	**0**	**1**

$S = A'.B + A.B' = A \oplus B$

$C = A.B$

Truth table of full adder

A	B	Cin	S	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$$S = A' B' Cin + A' B Cin' + A B' Cin' + A B Cin$$
$$= A' B Cin' + A B' Cin' + A B Cin + A' B' Cin$$
$$= (A' B + A B') Cin' + (A B + A' B') Cin$$
$$= (A \oplus B) Cin' + (A \oplus B)' Cin$$
$$= A \oplus B \oplus Cin$$

$$Cout = A' B Cin + A B' Cin + A B Cin' + A B Cin$$
$$= Cin (A' B + A B') + A B (Cin' + Cin)$$
$$= A B + Cin (A \oplus B)$$

Truth table of half subtractor

A	B	**d**	**b**
0	0	**0**	**0**
0	1	**1**	**1**
1	0	**1**	**0**
1	1	**0**	**0**

d=A’.B + A. B’
b= A’.B

Truth table of full subtractor

A	B	bin	d	bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

d = A'.B'.bin + A'.B.bin' + A.B'.bin' + A.B.bin

= A'.B.bin' + A.B'.bin' + A.B.bin + A'.B'.bin

= (A'.B + A.B') .bin' + (A.B + A'.B').bin

= (A⊕B). bin' + (A⊕B)'. bin

= A⊕B⊕bin

bout = A'.B'.bin + A'.B.bin' + A'.B.bin+ A.B.bin

= A'.B.bin' + A'.B.bin + A.B.bin + A'.B'.bin

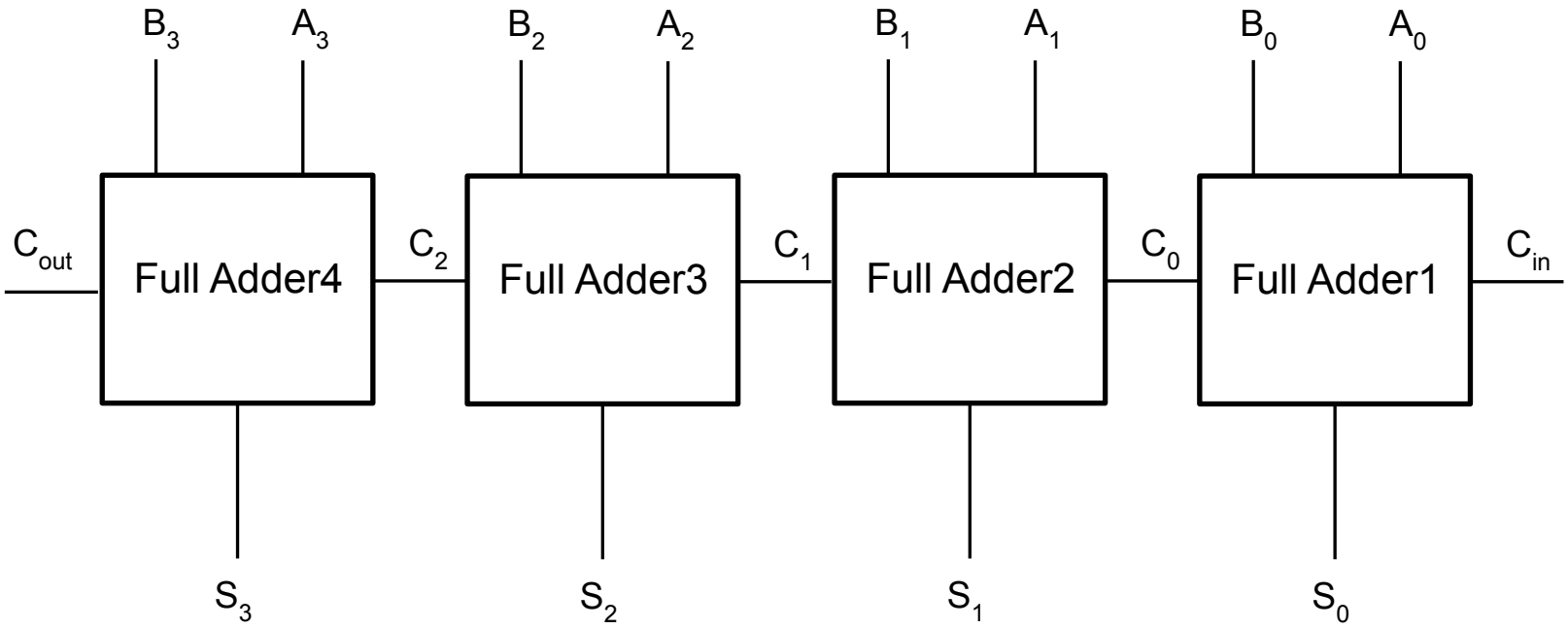
= A'.B.(bin'+ bin) + (A.B + A'.B').bin

= A'.B + (A⊕B)'. bin

Addition of two 4 bit binary numbers

```
      1 1
A   1 0 1 1
B   1 0 0 1
-------------
S  1 0 1 0 0
```

Ripple Carry Adder



Carry look ahead adder

$S_i = A_i \oplus B_i \oplus C_i = P_i \oplus C_i$

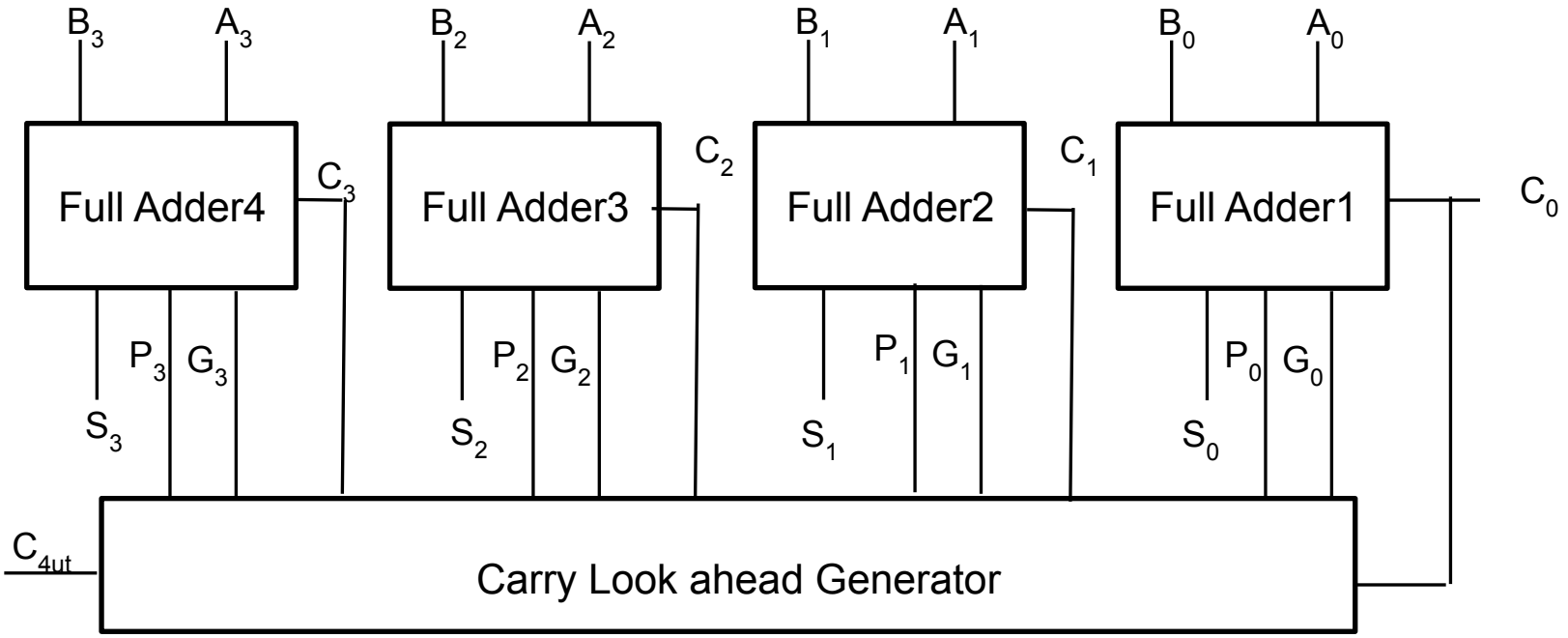
$C_{i+1} = A_i \cdot B_i + (A_i \oplus B_i) \cdot C_i = G_i + P_i \cdot C_i$

$C_1 = G_0 + P_0 \cdot C_0$

$C_2 = G_1 + P_1 \cdot C_1 = G_1 + P_1 \cdot G_0 + P_1 \cdot P_0 \cdot C_0$

$C_3 = G_2 + P_2 \cdot C_2 = G_2 + P_2 \cdot G_1 + P_2 \cdot P_1 \cdot G_0 + P_2 \cdot P_1 \cdot P_0 \cdot C_0$

$C_4 = G_3 + P_3 \cdot C_3 = G_3 + P_3 \cdot G_2 + P_3 \cdot P_2 \cdot G_1 + P_3 \cdot P_2 \cdot P_1 \cdot G_0 + P_3 \cdot P_2 \cdot P_1 \cdot P_0 \cdot C_0$



Addition- Subtraction Example

0111 (A)
0011 (B)

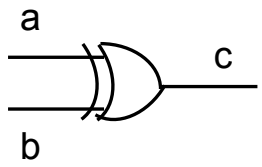
1010 (S)

0111 (A)
0011 (B)
1’ s complement of B is 1100
2’ s complement of B is 1100 + 1
-B = 1101
0111 (A)
1101 (-B)

10100 (S)

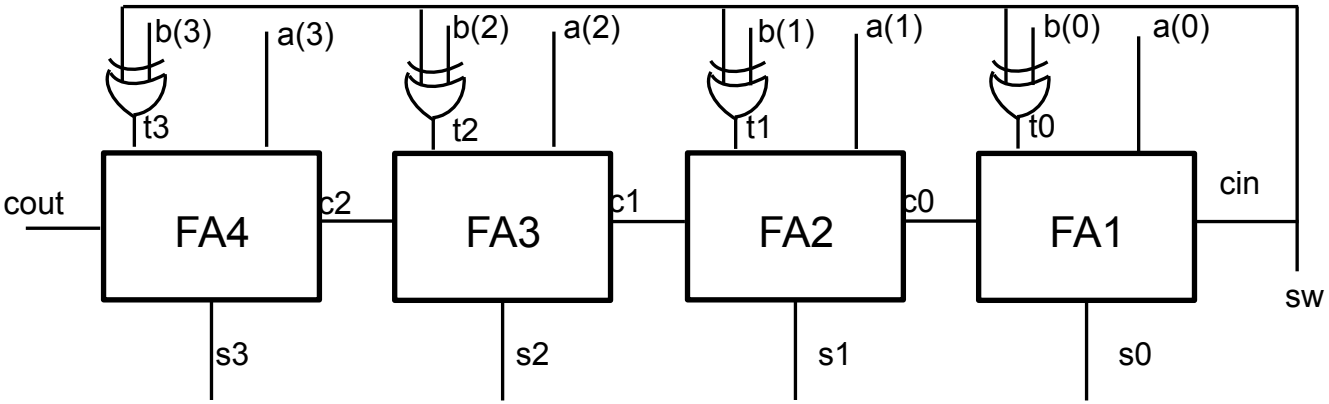
Truth table of XOR gate

A	B	**F**
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**0**



$c = a \oplus b$

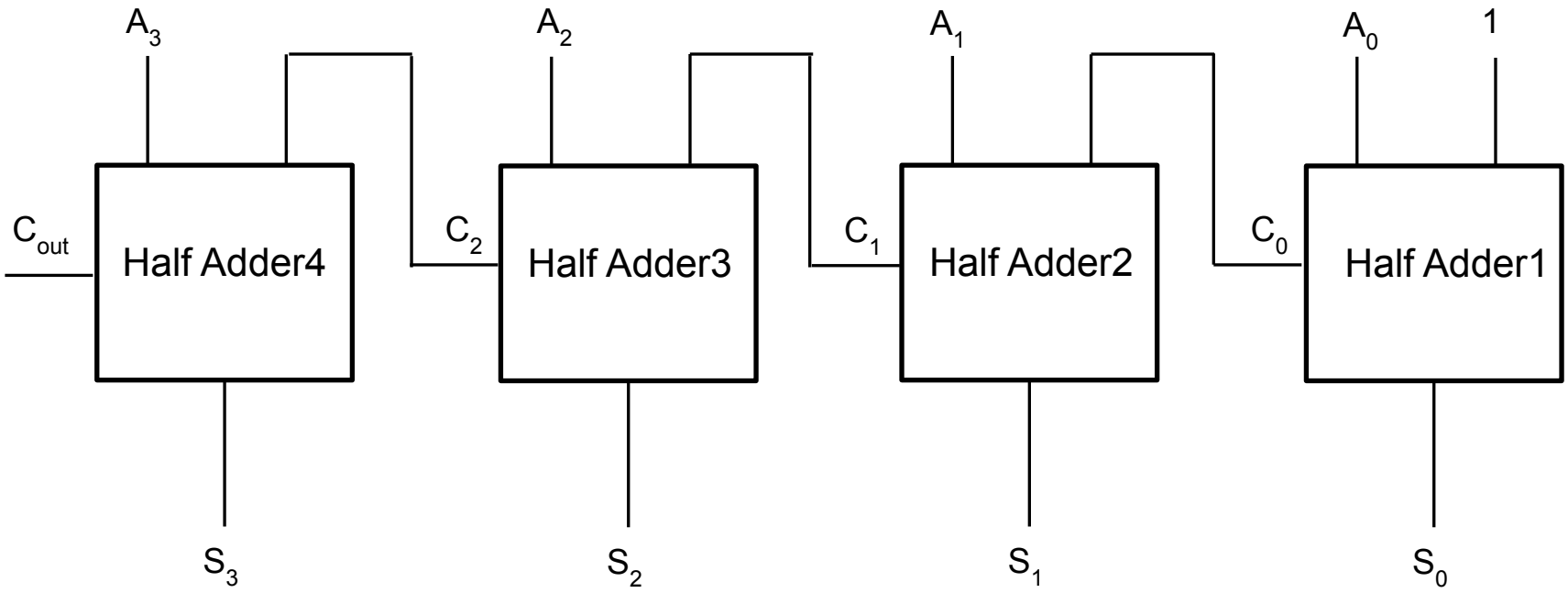
Adder – Subtractor composite unit



Binary 4 bit incrementer

```
      1 1
A   1 0 1 1
  +       1
-------------
S   1 1 0 0
```

Binary 4 bit incrementer circuit

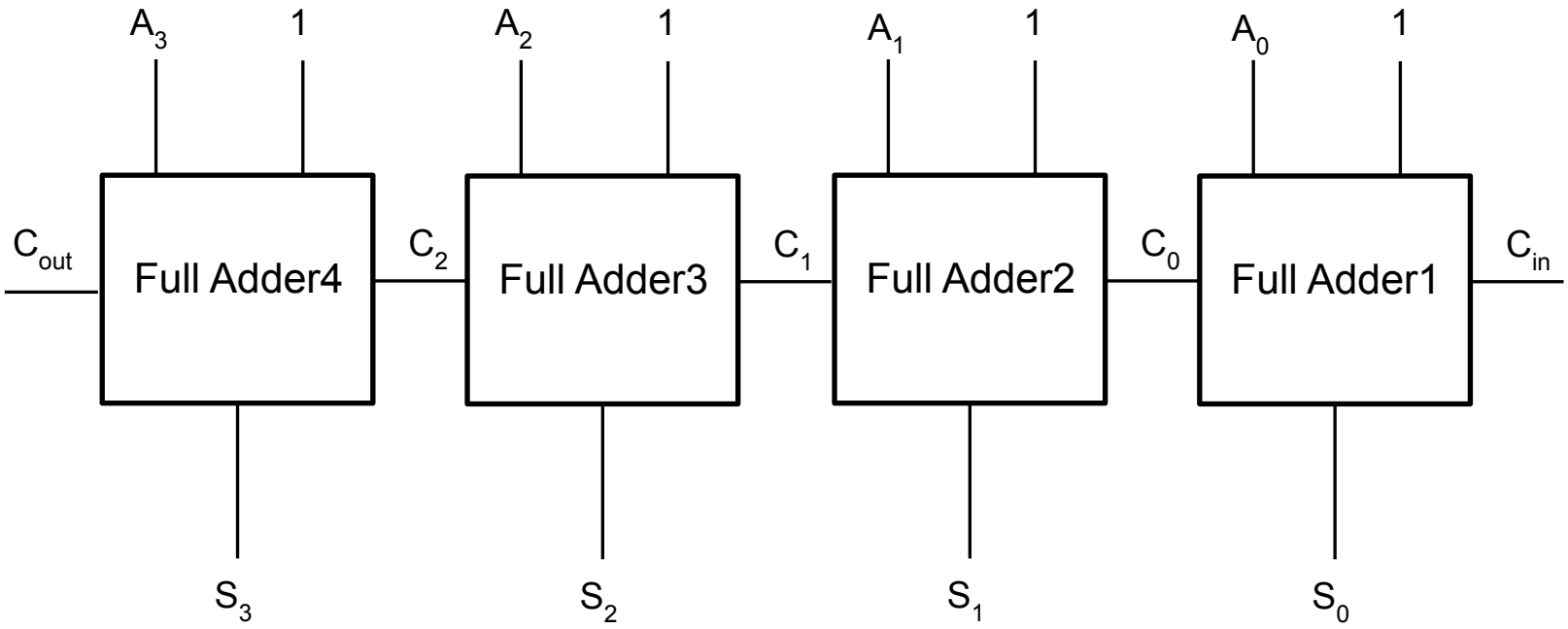


Binary 4 bit decrementer

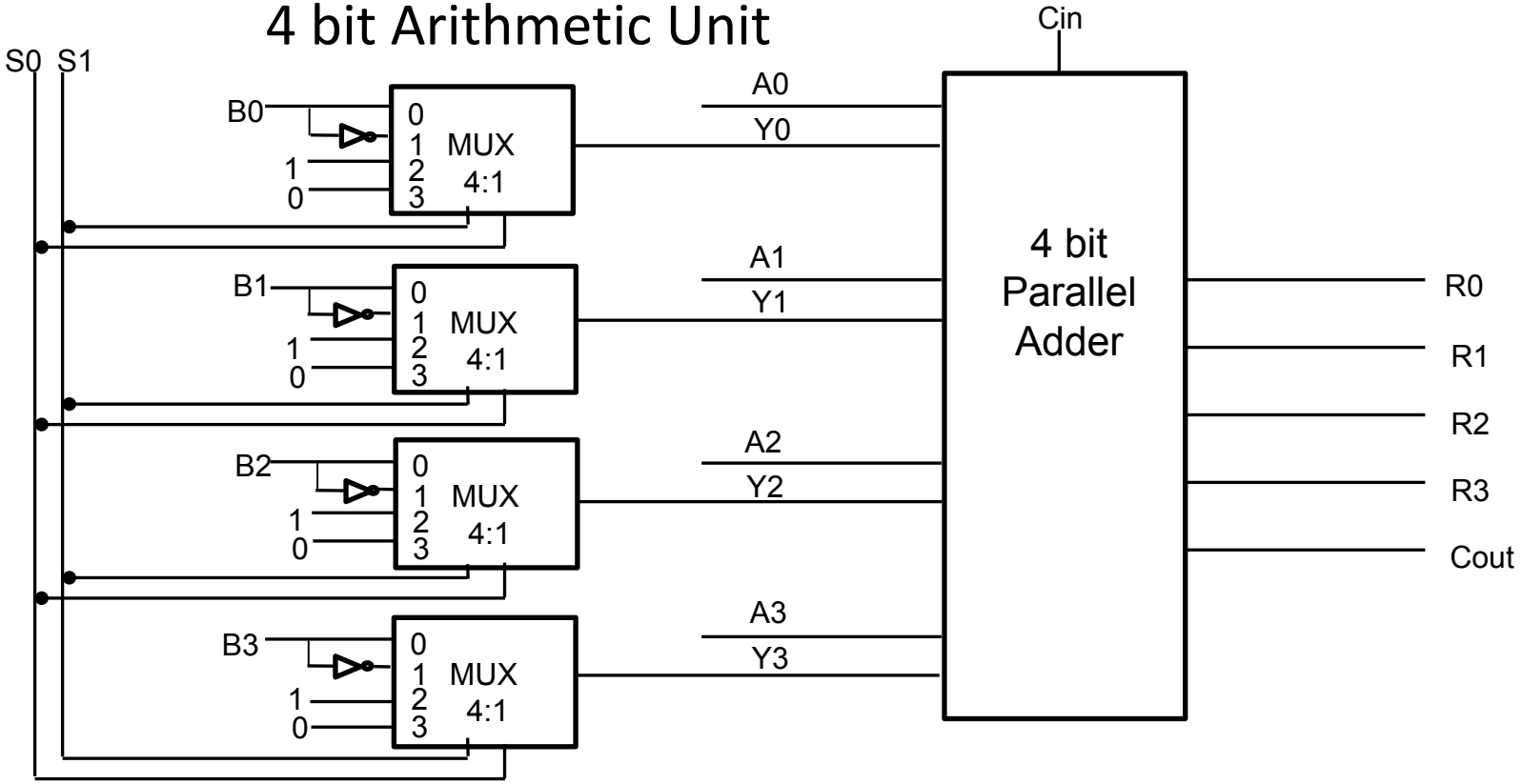
4 bit representation of +1	0001	
1's complement	1110	+1
2's complement	1111	(-1)

```
        1 1 1
A       0 1 1 1  (7)
+       1 1 1 1  (-1)
-----------------
S   X   0 1 1 0  (6)
```

Binary 4 bit decrementer circuit



4 bit Arithmetic Unit



S1	S0	Cin	Y	F=A+Y+Cin	Operation
0	0	0	B	F=A+B	Addition
0	0	1	B	F=A+B+1	Addition with carry
0	1	0	$\overline{B}$	F=A+$\overline{B}$	Subtraction with borrow
0	1	1	$\overline{B}$	F=A+$\overline{B}$+1	Subtraction
1	0	0	1	F=A -1	Decrement
1	0	1	1	F=A	Transfer
1	1	0	0	F=A	Transfer
1	1	1	0	F=A+1	Increment

Thank You